Measuring Soft Matters Using Nanodiamond Based Orientation Sensing

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The optical properties of nitrogen vacancy (NV) centers in diamond are sensitive to their spin states, making NV centers effective quantum sensors for applications ranging from condense matter physics to biomedicine. The long spin coherence time of NV center electrons make it particularly attractive in biological applications. The NV centers are particularly sensitive to the magnetic field projected along the NV axis so that orientation change of a diamond sample (containing NVs) would cause detectable modulation in its optically detected magnetic resonance spectrum, a method known as vector magnetometry. In the present work, we demonstrate a "synchronized" tracking of the three dimensional (3D) translational and 3D rotational motion of diamond particles based on nitrogen vacancy center based vector magnetometry. The time-dependent 3D rotation tracking is featured with high angular sensitivity, being able to disclose tiny rotations of the particle. Using this method, we have monitored the 3D translation and 3D orientation evolution of diamond particles anchored on a lipid vesicle derived from cells, or plasma membrane of live cells. Quantitatively analysis of the translation and orientation motions of the diamond particles has been carried out, and the specific characteristics of the motions are discussed to understand the interaction between the diamond particle and the lipid membrane.

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